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ABSTRACT

The Urban Mathematics Collaborative (UMC) project has the goal of contributing to the improvement of mathematics education in the inner-city schools by identifying models to enhance the professional lives of teachers and encouraging the entry of high school mathematics teachers into a larger mathematics community including mathematicians from higher education and industry. This document is a 5-year site report on the Twin Cities UMC from its inception in 1985 through June 1990. The intent is to reflect on the development of the collaborative, noting the changes that have taken place in regard to the context in the collaborative operated, the collaborative's management structure, and the focus of its activities. This final site report addresses the major influences exerted on the collaborative and the directions the collaborative has taken. Some conclusions are reached regarding both the collaborative's development and achievements in light of its specific goals as well as the goals of the total UMC project. (MDH)

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December 1991
Program Report 91-5 TC

TWIN CITIES URBAN MATHEMATICS COLLABORATIVE

FIVE-YEAR SITE REPORT

A Final Report to the Ford Foundation on the Urban Mathematics Collaborative (UMC) Project

Norman L. Webb, Susan D. Pittelman, Thomas A. Romberg, Allan J. Pitman, Edel M. Reilly, and James A. Middleton

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Norman L. Webb, Susan D. Pittelman, Thomas A. Romberg, Allan J. Pitman, Edel M. Reilly, and James A. Middleton

Report from the
Urban Mathematics Collaborative Documentation Project

Wisconsin Center for Education Research
School of Education
University of Wisconsin
Madison, Wisconsin

December 1991

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I. INTRODUCTION

This document is a five-year Site Report on the Twin Cities Urban Mathematics Collaborative from its inception in 1985 through June, 1990. The intent is to reflect on the development of the collaborative, noting the changes that have taken place in regard to the context in which the collaborative operated, the collaborative's management structure, and the focus of its activities. It is not the intent of this report to review the development of the collaborative; this has been done in the annual reports. This final Site Report addresses the major influences exerted on the collaborative and the directions the collaborative has taken. Some conclusions are reached regarding both the collaborative's development and achievements in light of its specific goals as well as the goals of the total Urban Mathematics Collaborative project.

The Urban Mathematics Collaborative Project

In 1984, the Ford Foundation initiated the Urban Mathematics Collaborative (UMC) project to improve mathematics education in inner city schools and to identify new models for meeting the on-going professional needs of urban teachers. In February, 1985, the Foundation awarded five grants to establish urban mathematics collaboratives in Cleveland, Minneapolis-St. Paul, Los Angeles, Philadelphia, and San Francisco. In addition, the Ford Foundation established a Documentation Project at the University of Wisconsin/Madison chronicle the development of the new collaboratives and a Technical Assistance Project (TAP) at the Education Development Center (EDC) in Newton, Massachusetts, to serve as a source of information for the collaborative projects (Romberg & Pitman, 1985). During the next 18 months, UMC projects were funded in Durham, Pittsburgh, San Diego, St. Louis, Memphis, and New Orleans, for a total of eleven collaboratives (Webb, Pittelman, Romberg, Pitman, Fadell, & Middleton, 1989). In August, 1987, an Outreach Project was funded at EDC to publicize and expand the UMC effort. In August of 1989, the Ford Foundation awarded replication grants to three additional sites: Dayton, Ohio; Columbus, Georgia; and Milwaukee, Wisconsin. In April, 1991, the fifteenth and final collaborative, the Greater Worcester Urban Mathematics Collaborative, was established in Massachusetts. A map indicating the location of UMC projects is presented in Figure 1.

The
Urban Mathematics Collaborative Project

Funded by The Ford Foundation

- **Cleveland Collaborative for Mathematics Education (C^2ME)**
  Cleveland, Ohio
- **Durham Collaborative: The Durham Mathematics Council**
  Durham, North Carolina
- **Los Angeles Urban Mathematics/Science/Technology Collaborative (LAUM/S/TC)**
  Los Angeles, California
- **Memphis Urban Mathematics Collaborative**
  Memphis, Tennessee
- **New Orleans Mathematics Collaborative (NOMC)**
  New Orleans, Louisiana
- **Philadelphia Math Science Collaborative**
  Philadelphia, Pennsylvania
- **Pittsburgh Mathematics Collaborative**
  Pittsburg, Pennsylvania
- **St. Louis Urban Mathematics Collaborative**
  St. Louis, Missouri
- **San Diego Urban Mathematics Collaborative**
  San Diego, California
- **San Francisco Mathematics Collaborative**
  San Francisco, California
- **Twin Cities Urban Mathematics Collaborative**
  Minneapolis-St. Paul, Minnesota

Replication Sites

- **Columbus Regional Mathematics Collaborative (CRMC)**
  Columbus, Georgia
- **Dayton-Montgomery County Public Education Fund Mathematics Collaborative**
  Dayton, Ohio
- **Greater Worcester Urban Mathematics Collaborative**
  Worcester, Massachusetts
- **Milwaukee Metropolitan Mathematics Collaborative (M^3C)**
  Milwaukee, Wisconsin

Figure 1. The National Network of Urban Mathematics Collaboratives.

During the five years covered in this Site Report, mathematics education in the United States has changed. When the Ford Foundation initiated the UMC project in 1984, a consolidated effort to reform mathematics had not yet begun, although the potential of the mathematics education community for achieving reform was envisioned. In this regard, the UMC project was innovative in mobilizing a group of inner-city teachers to increase both their sense of professionalism and their connections with mathematicians in the business community and in higher education. Between 1985 and 1990, mathematics education in this country began to change dramatically. In an effort to develop a new mandate based on such studies as *Renewing United States Mathematics: Critical Resource for the Future* (Commission on Physical Sciences, Mathematics, and Resources, 1984) and *A Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence in Education, 1983), the Mathematical Sciences Education Board in 1989 issued *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* and the National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards for School Mathematics*. As the collaboratives matured, the movement to change mathematics education in the country took on momentum, creating a new environment for the collaborative network. What began as a project designed to enhance the professional development of urban teachers evolved into a catalyst for the reform of mathematics education.

At each site, the UMC project supports collaboration among school mathematics teachers and between teachers and mathematicians from institutions of higher education and industry; it also encourages teacher membership and participation in a broad-based local mathematics community. Although the guiding principle behind the UMC effort has been that the teacher is and will remain at the hub of the educational process, it has become evident that many teachers--and especially those in inner-city schools--are overworked; lack support and material resources; and are isolated from their colleagues, from other professionals, and from the rapidly changing field of mathematics. Thus, the focus of the UMC project remains rooted in the premise that collegiality among professional mathematicians can reduce teachers' sense of isolation, enhance their professional enthusiasm, expose them to a vast array of new developments and trends in mathematics, and encourage innovation in classroom teaching.

Structure of the Five-Year Summary

The Five-Year Summary presented in the following chapter is comprised of six sections. The first section provides a brief overview of the collaborative. In the second section, the purpose of the collaborative is presented, as stated in its proposals to the Ford Foundation. The goals outlined in the collaborative's final request for funds to the Ford Foundation are contrasted with those specified in its initial proposal. The third section discusses the context within which the collaborative operated and the extent to which this has remained stable or has changed over the five-year period. Topics addressed in this section include demographic information on the surrounding community, changes in school district administration and enrollment and in the teacher population targeted by the collaborative, and significant changes occurring in mathematics and in the professional environment. The fourth section of the report describes the management structure adopted by the collaborative and changes that occurred in that structure over the five-year period. The fifth section covers the collaborative's activities in relation to four major themes that emerged from the documentation process as dominant in most collaboratives: socialization and networking, increased knowledge of mathematics content, teacher professionalism, and teacher leadership. These themes are used as a focus to organize ideas and to reflect on the collaborative's development with respect to some overriding expectations of the UMC project. The sixth and final section presents the reflections of Documentation Project staff on the approach the collaborative took to achieve its goals and the perceived outcomes in the areas of collaboration, professionalism, and mathematics focus.

The information presented in the Site Report is both a condensation and synthesis of information collected over the span of the UMC Documentation Project. Data were collected through monthly reports, the electronic network, four large-scale surveys, two demographic surveys, site visits, and case studies. These data-collection instruments and procedures are described in detail in the *UMC Guide to Documentation* (Pittelman, Webb, Fadell, Romberg, Pitman, & Sapienza, 1991). Detailed information about the Urban Mathematics Collaborative project is presented in six annual reports, four technical reports, and a set of case studies prepared by the Documentation Project. All of these reports are listed in the References. The Site Reports, which offer a retrospective summary of each collaborative's efforts over the grant period, have not been reviewed by

collaborative personnel and thus present the reflections solely of the Documentation Project staff.

II. FIVE-YEAR SUMMARY: 1985-1990

A. Overview

The Twin Cities Urban Mathematics Collaborative (TCUMC), one of the five collaboratives established in 1985, targets all of the middle school and secondary school mathematics teachers in Minneapolis and St. Paul, Minnesota. With a focus on stimulating the thinking of mathematics teachers, establishing collegial relationships, and developing a greater sense of professionalism among the teachers, the collaborative has from its beginning had a strong interest in teachers becoming more knowledgeable about mathematics. The two districts served by the collaborative have faced major economic pressures over the span of the collaborative's operation, resulting in such action as the reassignment of mathematics teachers from high schools to junior high schools and the initiation of an early retirement option. Both districts experienced a changing student population attributed to the flight of middle class families to the suburbs and an influx of minorities, including Southeast Asian immigrants. Associated with the growth in a lower socio-economic population has been an increase in problems more characteristic of inner cities, which had not been prevalent in the Twin Cities prior to the latter part of the 1980s.

The collaborative is funded through the School of Mathematics of the University of Minnesota-Minneapolis, one of two UMC collaboratives hosted by universities, and functions with a relatively low-cost administrative structure. Initially, administrative duties were performed by the collaborative's director and coordinator out of the Special Projects Office of the School of Mathematics, and then were shifted to the Governing Board, which provided the leadership that enabled the collaborative to achieve its permanent structure. Teachers have assumed a role in governance since the early stages of the collaborative by serving on the Teacher Advisory Committee, then later on the Building Representatives group and on the Governing Board.

The collaborative has successfully produced a series of programs including dinner meetings, summer institutes, workshops, academic year seminars, a newsletter, meetings on educational policy issues, and it has sponsored teachers' attendance at professional meetings. Forty to 50 teachers have become an active core in the Building Representatives group and other collaborative activities. The collaborative has received strong support from mathematicians and mathematics educators at several of the colleges in the area,

from representatives of the High Technology Council, and from area businesses. The two districts have provided financial support to the collaborative and each has involved its mathematics supervisor. However, the collaborative has not succeeded in actively involving the top level administration of either district. At the end of the five years, a mid-life committee was meeting to review and recommend adjustments in the governing structure of the collaborative, and to provide permanence to the collaborative. Over its duration, the collaborative has sponsored programs emphasizing mathematics and problem solving, resulting in a strong push by teachers and others for mathematics education reform. The mathematics emphasis also has helped to maintain the interest of representatives from higher education and business who have been active in the collaborative's affairs over the course of its existence. A major challenge faced by the collaborative from the beginning has been the development of trust and understanding between a very active group of collaborative teachers and the collaborative administration.

B. Purpose

The main purposes that have guided the development of the collaborative over the five years are stated in its original proposal: "To extend the sense of professionalism among secondary school mathematics teachers, provide for their further intellectual stimulation and renewal, and establish collegial and professional relationships among the teachers and the wider mathematical community of the Twin Cities." As the collaborative matured, these purposes were refined to address more sophisticated mathematics issues, political concerns, expansion of the collaborative's influence, and longevity. To guide the collaborative and to achieve this focus, specific steps were outlined that included: involving teachers in activities in which they are able to exert more responsibility and control over their professional lives; providing a broad range of mathematical activities; expanding industrial involvement; integrating pre-college mathematics education groups into the collaborative; and increasing the visibility of the collaborative within the school districts as well as in the Twin Cities area. As the collaborative sought a structure that would lead to its permanence, the Governing Board approved specific goals such as continuing to sponsor activities that had been well received by teachers and others; initiating a process to establish a new governance structure; hiring a part-time coordinator and using more volunteer help; raising funds; and seeking nonprofit tax-exempt status. Although the purposes for the collaborative did not change, a refined program for the

organization of the collaborative was developed and a systematic effort to establish a structure that would survive into the future was adopted.

The secondary and middle school mathematics teachers in Minneapolis and St. Paul have been the target population for the collaborative from its beginning. Even though the Ford Foundation stipulated in its early documents that the collaboratives were to be for secondary teachers, the Twin Cities Urban Mathematics Collaborative successfully made a case for including middle and junior high school teachers because in Minnesota teachers at these two levels are required to have secondary certification and because teachers are frequently transferred between the levels. Thus, the Twin Cities Urban Mathematics Collaborative became the first collaborative to specifically target both middle and secondary school mathematics teachers, including teachers from private middle and secondary schools in the two cities: The total target population consisted of the approximately 220 middle and secondary mathematics teachers in both districts and nearly 50 mathematics teachers in area private schools. The mailing list for the collaborative newsletter, which was sent to all of the teachers, some district staff, business and industry representatives, and selected professionals in area colleges and universities, reached over 400. Although 40 to 50 teachers were most active, the collaborative's efforts assured that all teachers in its target population were at least aware of its existence, and over half in some way participated in collaborative activities.

C. Context

The Twin Cities Urban Mathematics Collaborative serves a metropolitan area that has experienced a decline in population of about 6 percent over the five-year period--from nearly 650,000 in 1985 to less than 600,000 in 1990 (approximately 352,000 in Minneapolis and 242,000 in St. Paul). Even with the decrease in overall population, the student enrollment in each of the districts has steadily increased.

Minneapolis Public Schools

In the fall of 1989, enrollment for the Minneapolis Public School (MPS) district was 42,695, a 14 percent increase from its enrollment of 37,500 in 1985-86. The

distribution of the student body by ethnic groups shifted from about 60 percent white in 1985-86 to 50 percent white in 1989-90. The fastest expanding ethnic groups were Asians (7% to 10% increase over the two-year period, 1987-1989) and blacks (27% to 31%). The relatively large proportion of American Indian students remained constant at around 7 percent. Hispanic students constituted less than two percent of the student enrollment. In 1990, approximately 2,850 K-12 students were classified as LEP (Limited English Proficiency) students and 33 percent of all students were from families that received AFDC. The annual dropout rate rose slightly from 10 percent in 1986-87 to over 11 percent in 1988-89. Even though the district's total student enrollment increased from the beginning of the collaborative, student enrollment in the seven high schools declined by approximately 11 percent, to 10,635, in 1989-90.

The MPS Board of Education has seven elected members. The budget for the 1989-90 school year was $180.4 million, an increase from the approximately $164 million in the 1985-86 school year. Of this, approximately 40 percent was provided by the state, 4 percent from federal funds, 55 percent from local sources, and 1 percent from other sources. Superintendent of Schools Dr. Robert Ferrera replaced Dr. Richard Green, who resigned in 1988. In 1989-90, there were 60 schools in the district: 7 senior high schools, 6 junior high schools, 45 elementary schools, and 2 other schools.

In 1989-90, the MPS employed approximately 2,700 teachers. Of these, 66 taught high school mathematics and 43 taught middle school mathematics. Nearly all of the mathematics teachers were white; there was one black teacher and two teachers from other ethnic groups. All mathematics teachers hold bachelor's degrees and are certified in mathematics; Minnesota state policy requires a teacher to be certified in the subject area of a course in order for the student to receive credit for that course. In 1989-90, two of the mathematics teachers held doctorates. The Minneapolis Federation of Teachers is the bargaining agent for the district's teachers. Salaries for the MPS teachers in the 1989-90 school year ranged from $21,015 to $46,766, with the average at $35,000. The contract includes 184 school days. Declining high school enrollments and other economic difficulties have caused some staff reduction since the beginning of the collaborative. In 1986-87, non-tenured high school mathematics teachers were released. In June of 1988, steps were taken by the district to eliminate approximately 200 secondary school teaching positions amidst an outcry from the public against these cuts.

The Minneapolis Public Schools require that for high school graduation students take one mathematics course and one science course in Grades 10-12, as well as attain a passing score on a benchmark test. About two thirds of the high school students were enrolled in mathematics classes in 1988-89. The curriculum was somewhat traditional, yet the teachers have considerable autonomy in terms of the content and pacing of lessons. In the spring of 1989, as a result of a district reorganization, the very active mathematics curriculum supervisor had his supervisory responsibilities reduced to 40 percent time.

St. Paul Public Schools

The student enrollment in St. Paul Public Schools (SPPS) increased to 34,585 in 1989-90, representing a 13 percent increase from the 30,000 pupil enrollment in the 1984-85 school year. As in the Minneapolis Public Schools, the student population is shifting toward a greater percentage of underrepresented students. In one year, 1988 to 1989, the percentage of white students dropped from 62 percent to 60 percent while the percentage of black and Asian students each increased by one percent to 16 percent of students enrolled. The other ethnic groups remained constant, with Hispanic enrollment at 6 percent and Native American enrollment at 2 percent. In 1989-90, a total of 9,454 students were from families receiving AFDC. The annual dropout rate for the 1989-90 school year was approximately 12 percent.

The seven-member Board of Education for SPPS oversaw the district's expenditure of $215.1 million for the school year 1989-90. Dr. David Bennett has served as superintendent since 1984. There are 57 schools in the district: 40 elementary, 8 junior high/middle school, 6 senior high schools, and 3 other schools. The SPPS has a director for mathematics, science, and computer technology who has served in this capacity throughout the period of the collaborative's existence.

In 1989-90, SPPS had approximately 2,400 teachers and licensed staff members, 9 percent of whom are from underrepresented ethnic groups. Of the 100 teachers who taught high school mathematics, only 2 teachers were from minority groups. All high school teachers have at least a bachelor's degree and over 75 percent have earned a master's degree. All mathematics teachers are certified to teach mathematics and 90 percent have tenure. In 1989-90, SPPS teachers' salaries ranged from $22,347 to $40,556

and averaged $35,000. In 1987-88, the average number of inservice days for the high school mathematics teachers was four days during the school year and four days prior to the beginning of the academic year. Most of the teachers belong to the St. Paul Federation of Teachers, the local teachers union. During the five years of the collaborative, teachers experienced some concern regarding possible re-assignment and the threat of layoffs because of budget-trimming measures. At the same time, the teacher-student ratio increased at the secondary level to 1:33.

To graduate from SPPS, students are required by the state to complete one mathematics or science course in Grades 10 through 12. In addition, beginning with 1989-90 seniors, students must earn 40 credits and pass benchmark tests in mathematics, reading, writing, and language for graduation.

Many programs to enhance the professional development opportunities for teachers in the Twin Cities have been sponsored in part by businesses, university, and community funds. The Minnesota Mathematics Mobilization (M^3), a statewide consortium that is partially funded by the National Science Foundation, addresses mathematical issues for all levels of education. The consortium issues a newsletter five times during the year and conducts conferences, such as the all-day conference on equity that was held in April, 1989. Local and state mathematics societies including the Minneapolis Math Club, an organization of secondary and elementary teachers, offer a variety of opportunities for professional development. In 1990, a coalition of Minnesota companies awarded $36,500 grants to fund innovative short-term programs in the Twin Cities school districts and Education Venture Inc. (EVI) awarded grants of up to $500 each to more than 100 area teachers for special programs and curriculum support. The EVI grants, now in their sixth year, are funded by 40 companies. Several special summer programs are also available to students and teachers. Minnesota has an open enrollment program allowing public school students to transfer to a school in any district if racial balances in desegregated districts are not skewed and the school of choice has space. Only about 2,000 students in the state were expected to transfer in the 1989-90 school year. Minnesota high school juniors and seniors are allowed to take college courses at state expense while still enrolled in high school. Districts have opposed this program because the program diverts funds from the districts to higher education institutions. In 1987-88, about 5,000 students took advantage of this program.

D. Management Structure

To initiate the development of a collaborative in the Twin Cities area, the Ford Foundation contacted the School of Mathematics of the University of Minnesota, chaired by Willard Miller. Out of this initial contact, the Twin Cities Urban Mathematics Collaborative was established, directed jointly by Willard Miller and Harvey Keynes, director of the Office of Special Projects for the School of Mathematics. Various staff members from the Office of Special Projects have served as half-time coordinators for the collaborative. Two committees were formed to assist in the collaborative's governance and to establish communication among members of the collaborative's administration, teachers and others in the community. The Steering Committee, including Dr. Keynes and a 15-member board, consisted of representatives of the University of Minnesota, the Minneapolis and the St. Paul School districts, the Science Museum, Macalester College, and two corporations, Honeywell and St. Paul Fire and Marine Insurance Co. The Steering Committee designated three subcommittees: the Industrial Collaboration committee, which was responsible for investigating links with industry; the Professionalization Subcommittee, which was charged with identifying activities and procedures to address the issue of teacher professionalism; and the Funding and Support Committee, which determined various forms of financial and non-financial support for current and future activities of the collaborative. The Teacher Advisory Committee (TAC), formed in the fall of 1985 and composed of five teachers, provided a line of communication between collaborative teachers and the director. Teachers who served on this committee had all participated in the 1985 Summer Institute. Two TAC members also served on the Steering Committee.

The collaborative underwent several changes in its administrative structure during the first five years. By 1986, Dr. Keynes had become the sole project director and remained in that position until the management structure of the collaborative was reorganized in 1989. Also during 1985-1986, Sally Sloan, a teacher at Edison High School in Minneapolis and a member of the TAC, became the collaborative's teacher coordinator and newsletter co-editor, along with on-site observer and collaborative historian, Gerry Sell. To facilitate reaching all of the targeted collaborative teachers and to build teacher self-governance into the collaborative structure, a Building Representative group replaced the TAC at the end of the 1986-87 school year. The Building Representatives were responsible for disseminating information regarding collaborative activities and policy.

One teacher from each of the schools represented in the collaborative was recruited to serve in the Building Representatives group. During the collaborative's first year, each member was given a $100 stipend. The group grew to 43 members, including 35 official building representatives as well as several teachers from private and parochial schools.

The role of the Steering Committee evolved over the duration of the collaborative from being relatively passive in the first year to taking a greater interest in the decision-making process, especially issues of governance and leadership, by 1986-87. In 1987-88, in response to the Ford Foundation's requirement for a permanence proposal, the Steering Committee set up a Permanence Committee to develop a plan for permanence for the collaborative. Steve Watson, from the Special Projects Office of the University of Minnesota School of Mathematics and later the executive director of the Minnesota High Technology Council, was hired to facilitate development of the permanence proposal. Several issues reflecting the unique geographic, demographic, and political context of the Twin Cities were raised in the process. Of particular interest was the issue of whether the collaborative should restrict its outreach activities to include only "inner-city" teachers, consistent with the original intent of the Ford Foundation, or whether it should be allowed to include teachers from suburban or statewide schools. The latter scenario was proposed and was found acceptable by the Ford Foundation. In addition, the Permanence Committee recommended the dissolution of the Steering Committee, to be replaced by a central Governing Board. To minimize administrative costs for the collaborative, the number of paid staff positions was reduced and replaced with unpaid volunteers. The Building Representatives group was given a budget of $3,000 to fund its activities.

During its first year of operations, 1988-89, the Governing Board of the TCUMC had filled 10 of its 14 positions. Members included Board Chair Steve Watson, Harvey Keynes, two building representatives, the mathematics consultant from each school district, two representatives from higher education, one business representative, and one member from the Board of the St. Paul Public Schools. Steve Watson, as chair, took over many of the responsibilities of the project director in 1988, while Professor Keynes' role shifted from project director to fiscal agent and administrative director. A four-member executive committee of the Governing Board, formed to handle decisions between quarterly meetings, was expanded to five members in 1990. In a parallel, but independent action, the Building Representatives also formed an executive committee.

At the close of the documentation period in June, 1990, two years following the change in management structure, the collaborative was reviewing its successes and making recommendations to reach a permanent structure. A Mid-Life Review Committee was appointed by Steve Watson in the spring of 1990 to consider issues such as the creation of a non-profit corporation, the collaborative budgets for the next two to four years, the relationship between the Building Representatives and the Governing Board, fund raising, the hiring and duties of a new coordinator, the tenure of Board members, and the future direction and structure of the collaborative.

E. Project Activities

Over the five-year period 1985-1990, the Twin Cities Urban Mathematics Collaborative sponsored a wide variety of activities to provide further intellectual stimulation and renewal to secondary school mathematics teachers in the Minneapolis-St. Paul area. The activities were designed to enhance professionalism and to create collegial networks among teachers and representatives of business and higher education. Throughout the five-year period, the collaborative's programming maintained a strong mathematics focus that centered around problem solving, balanced by the exploration of the mathematics curriculum and the mathematics students need to know. The collaborative also encouraged teachers to attend conferences and seminars sponsored by other organizations, but offered only limited financial assistance. The collaborative's program was strongly influenced by the national reform movement in education as well as by the expertise available through the University of Minnesota, the host institution of the TCUMC.

The activities of the Twin Cities collaborative are presented as they address the four themes that emerged from the documentation process as being dominant in the programming for the collaboratives in general. These themes were: Socialization and Networking, Increased Knowledge of Mathematics Content, Teacher Professionalism, and Teacher Leadership. Socialization and Networking activities, especially prominent in the formative years of the collaboratives, were designed primarily to initiate interaction among teachers and between teachers and mathematicians from business and higher education. These generally large-group activities were important to a collaborative's evolution since they brought members of the mathematics community together, enabled them to get to

know one another, and promoted networking. The second theme, Increased Knowledge of Mathematics Content, encompassed activities designed to provide teachers with mathematics-directed experiences and to increase the knowledge of teachers and others regarding current trends in mathematics and mathematics education. Many of these activities helped to activate the agenda of the mathematics reform movement at the collaborative sites. The third theme, Teacher Professionalism, emerged in activities structured to enhance teachers' conceptions of teaching as a profession. Collaboratives provided opportunities and incentives for teachers to attend professional organization meetings and made mathematics teachers aware of available grants and other opportunities for professional development. Some collaboratives paid teachers' dues for organization membership and arranged for teachers to observe other teachers and reflect on their teaching. The fourth theme, Teacher Leadership, had not been identified at the beginning of the UMC project, but gained greater attention as collaboratives found that teachers lacked the skills needed to organize professional efforts, to plan, and to develop the power within their group to generate systemic change. This theme was advanced by the EDC through the UMC Teacher Leadership Workshops which, beginning in the summer of 1989, were attended by from one to four teachers from each of the collaboratives. However, since this training was initiated by EDC rather than by the collaboratives, it is not discussed in the reports of the individual collaboratives.

In reflecting on collaborative activities as they related to the four themes, considerable overlap was noted, since most activities serve multiple purposes. A single activity may therefore be discussed under several headings.

Socialization and Networking

One of the initial goals of the Twin Cities Urban Mathematics Collaborative was to establish collegial and professional relationships among teachers and the wider mathematics community of the Twin Cities. The results of two programmatic efforts designed specifically to promote networking and communication were the Twin Cities Mathematics Society (TCMS) and the collaborative newsletter, *The Pentagon Papers*.

In addition, many of the collaborative's other programs helped foster stronger relationships among teachers and between teachers and mathematicians from the higher education and business communities. Among these were the Summer Institutes and the related Academic Year Seminars.

The Twin Cities Mathematics Society

The first program that the collaborative initiated when it was established in 1985 was the Twin Cities Pre-College Mathematics Society, which later became known as the Twin Cities Mathematics Society (TCMS). The Society was formed to organize functions that would facilitate professional and social contact among mathematics teachers and mathematicians from the higher education and industrial sectors. The TCMS, modeled after a successful mathematics society in Chicago, offered mathematics programs in an environment that was conducive to socialization and mathematics-related discussions among representatives from all three sectors. Each year, the TCMS sponsored a series of three to four dinner meetings. The first year, the dinners were completely paid for by the collaborative, but in 1986-87, a $2 reservation fee was instituted to discourage last-minute cancellations. In 1987-88, in an effort to help the organization become independent and self-supporting, membership in the TCMS was expanded to include teachers outside the collaborative's geographic boundaries. Similarly, collaborative members were asked to pay $5.00 for each dinner meeting (half the cost of the dinner), while non-collaborative teachers paid the full $10 cost. The increase in cost did not seem to affect attendance, however, and the dinner meetings during 1987-88 drew approximately 60-70 people, including good representation from the business and university communities. Beginning in the fall of 1988, all participants were required to pay the full cost of the dinner, which averaged about $10 in 1988-89 and $12 to $15 in 1989-90. The dinner meetings continued to be well-attended with attendance averaging about 60 in 1988-89 and about 40 in 1989-90, although no representatives from business attended the last dinner meeting in the 1988-89 series, nor the first in the 1989-90 dinner series.

Participants continued to value highly the opportunity to meet with others interested in mathematics at the TCMS dinner meeting programs. Initially, the teachers' comments addressed their appreciation for the opportunity to socialize and to get to know each other as well as representatives from the business and university sections, whereas in

the latter years of the program, teachers expressed appreciation for the opportunity to discuss mathematics with others interested in mathematics.

Summer Institutes and Academic Year Seminars

A major programming effort of the Twin Cities Urban Mathematics Collaborative were the Summer Institutes and the follow-up seminars that were held during the academic year. The collaborative offered a Summer Institute in 1985, 1986 and 1987. In addition, the collaborative sponsored the attendance of teachers at the National Science Foundation (NSF) Summer Institutes that were held as part of the Teacher Renewal Project in 1986 and 1987 on the University of Minnesota campus concurrent with the TCUMC Summer Institutes. The series of Academic Year Seminars, held to build on and extend the experience of the teachers who participated in the Summer Institutes, were attended by participants of both the TCUMC Institutes and the NSF Institutes. While promoting socialization and networking among teachers was not the primary goal of the institutes, teachers commented that one of the benefits of participation was the opportunity to get to know and to learn to work with other teachers as well as with professors in higher education. Similarly, the Academic Year Seminars provided the teachers with an opportunity to meet with their colleagues to discuss implementation of their classroom projects and to exchange ideas and information within a very supportive environment.

The Pentagon Papers

An important networking component of the Twin Cities Urban Mathematics Collaborative is the collaborative's newsletter, *The Pentagon Papers*. The newsletter, which was first published in December, 1985, under the name "Urban Mathematics Collaborative Newsletter," continues to be a primary source of information for the entire collaborative membership. Approximately 260 secondary mathematics teachers, including 50 private and parochial teachers, are on the mailing list, as well as numerous industrial, business, university, college, and school administrative personnel. The newsletter reports on meetings and activities that have taken place and announces future events. It also

publishes letters from readers and articles profiling local mathematicians. The number of issues published each year has varied, depending on available personnel. During 1987, for example, with the appointment of a teacher coordinator to assist the volunteer editor, five issues were produced; one during the summer and four during the academic year. During the 1989-90 school year, two issues were published, a fall issue and a spring issue. The spring issue was designed specifically to promote the accomplishments of collaborative teachers and to provide information about professional opportunities that are available.

Increased Knowledge of Mathematics Content

Throughout its development, the Twin Cities Urban Mathematics Collaborative has been strongly oriented to mathematics and to the expansion of teachers' knowledge about mathematics and mathematics education. A central theme of the collaborative is mathematical problem solving. This theme has been presented in a variety of contexts, all of which address the question of how to transform the teaching of mathematics from the presentation of facts and processes to one of problem solving. This thrust, along with the applications of mathematics and important issues related to the mathematics education reform movement have formed the basis for most of the collaborative's programming. The School of Mathematics at the University of Minnesota and other area colleges have provided intellectual leadership as well as instruction in helping teachers become better problem solvers and assisting them in the development of classroom materials to help their students improve in the area of problem solving.

Twin Cities Mathematics Society Dinner Meetings

While the dinner meetings of the TCMS did provide a valuable opportunity for teachers to socialize with one another as well as with representatives from business and higher eduction, the primary goal of the dinner meetings was to provide participants with an opportunity to discuss mathematical topics with other professionals. Many of the meetings, especially in the first few years, featured keynoters who spoke on mathematical topics. One speaker, for example, presented several famous problems in differential equations that remain unsolved. At these meetings, teachers were treated as mathematics colleagues, competent to understand and be interested in mathematical issues. As the

programming for the dinner meetings evolved, however, speakers were solicited from all three participating sectors--teachers, higher education, and business. In general, representatives from higher education addressed topics related to pure mathematics (for example, Fibonacci Numbers and the Pythagorean Theorem); representatives from business shared business applications of mathematics (such as problems that actuaries have to solve); and teachers presented classroom applications (such as teaching techniques related to problem solving and geometry). While it was a challenge to find speakers who would interest all of the participants, the collaborative was very successful in its efforts to offer a well-balanced program that would appeal to a majority of the Society's membership.

Summer Institutes and Academic Year Seminars

An important and very successful part of the collaborative's programming were the Summer Institutes which the collaborative sponsored in 1985, 1986, and 1987, and the follow-up seminars held during the academic year. The Summer Institutes, as a whole, provided teachers with new information and perspectives. All three of the Summer Institutes focused on some aspect of problem solving. During the three-week 1985 Institute, the participants (19 teachers representing 11 senior high schools) completed three projects: instructional units integrating content with specific problem-solving skills, a problem-solver's handbook, and a revision of a book that addressed going to the workforce. The Institute stressed content while addressing methodology. The 1986 Summer Institute focused on problem solving and enrichment in the junior high curriculum. Through the Institute, 17 participants developed a problem file to be used with their classes, and 15 of the teachers also developed curriculum modules to be shared with other participants and to be used as resources for junior high teachers. The 1987 Summer Institute focused on a problem solving approach to number theory. As part of the goal to help secondary teachers view themselves as members of the larger mathematical community, the Institute was designed to give teachers an opportunity to "indulge themselves as mathematicians, working on topics of genuine mathematical substance" that could be used to enrich virtually every subject in the secondary mathematics curriculum. Of the 20 participants, 8 were senior high teachers and the remaining 12 taught junior high. One of the reasons for the success of the Summer Institutes was that they were not "courses" in the traditional sense. The teachers were active participants and the outcomes were classroom materials produced by and for teachers.

During 1986 and 1987, the National Science Foundation (NSF) Teacher Renewal Project ran concurrently on the University of Minnesota campus with the UMC Summer Institutes. NSF and UMC participants shared common break times and attended industrial lectures together. In 1986, the Twin Cities collaborative sponsored the participation of five collaborative members in the NSF program.

The participants in each Summer Institute were invited to continue to meet throughout the academic year to discuss implementation of classroom projects that were developed during the Summer Institutes and to continue to address relevant topics, including a discussion of the NCTM *Curriculum and Evaluation Standards for School Mathematics*. The number of Academic Year Seminars varied. During the 1985-86 school year, for example, eight seminars were held, while in the 1986-87 and 1987-88 school year, four were scheduled. During both 1986-87 and 1987-88, the follow-up seminars were held in conjunction with the NSF Teacher Renewal Project.

Woodrow Wilson Summer Institutes and Follow-up Sessions

During the summers of 1988 and 1989, the collaborative sponsored one-week Woodrow Wilson National Fellowship Foundation Summer Institutes at the University of Minnesota. Both Woodrow Wilson Institutes were presented by four Master Teachers who had participated in a month-long seminar at Princeton University under the direction of the Woodrow Wilson Fellowship Foundation's "Teachers Teaching Teachers" program. Through this program, some of the best mathematics teachers from across the country received training to conduct institutes at selected sites.

The 1988 Institute, which focused on statistics, was designed to provide participants with new statistical techniques that could be used in any classroom. Participants used simple numerical and graphical methods to process, organize, and analyze real data. Topics included exploratory data analysis, sampling, probability, simulation, and inferences. The 1989 Woodrow Wilson Institute, which focused on functions and technology, was organized around three themes: teaching traditional topics in new and exciting ways; teaching previously inaccessible topics, now made possible by new technology; and the technology itself--calculators, computer, and powerful software. The

topics addressed were related to the concept of function and included numerical methods, geometric approaches to functions, data analysis, linear and non-linear functions, mathematical modeling, and matrix applications. The use of writing in mathematics and general approaches to problem solving served as guiding principles for the Institute.

While both Woodrow Wilson Institutes were open to all mathematics teachers in the Minneapolis metropolitan area, preference was given to collaborative members. The collaborative paid the registration fee for collaborative teachers and offered them a choice of either a stipend or graduate credits. Forty-one teachers, including 30 collaborative junior and senior high teachers, participated in the 1988 Woodrow Wilson Institute, and 27 teachers, including 16 collaborative teachers, participated in the 1988 Institute. Each Institute held a mid-year follow-up meeting at which participants had the opportunity to share what they have done in their classes based on ideas they received from attending the Institute. Teachers, especially those who attended the Statistics Institute, reported that as a result of the Institute, they had made some significant content changes in the classes they were teaching.

Additional activities focusing on mathematics and its applications sponsored by the collaborative were two workshops on graphing calculators offered in 1989-1990 and a tour of the Operations Center of Norwest Bank of Minneapolis in October, 1987. In April, 1988, the collaborative, the Minneapolis Mathematics Club, and the Minnesota Council of Teachers of Mathematics co-sponsored a wine-and-cheese reception for Sir Wilfred Cockcroft, who had recently been knighted for his work in mathematics reform in England.

Teacher Professionalism

The collaborative has successfully encouraged teachers to become more involved in professional meetings and organizations. Unlike most of the other UMC collaboratives which offered substantial funds to support teachers' attendance at meetings of professional organizations, the Twin Cities collaborative provided only minimal subsidies for teachers attending state, regional, and national conferences. Despite this, Twin Cities teachers have expressed a keen interest in professional organizations and activities, on both the local and national level. Approximately 12 teachers from the Twin Cities collaborative attended the

Annual Meeting of the National Council of Teachers of Mathematics in Chicago in April, 1988, even though the collaborative did not offer financial support. The 1987 Presidential Award winner, however, who was a collaborative member, chose to use his award funds to send seven teachers to the conference. Eight teachers attended the 1989 NCTM Annual Meeting in Orlando, Florida, and eight attended the 1990 NCTM Annual Meeting in Salt Lake City, using collaborative grants of $100 in 1989 and $80 in 1990.

Collaborative teachers took an active role in NCTM local and regional conferences. Nearly 20 collaborative teachers played a key role in organizing, planning, and working at the regional NCTM conference that was held in Minneapolis in 1987. Collaborative teachers also were active participants in the Minnesota Council of Teachers of Mathematics (MCTM). Thirty-four collaborative members served as either speakers or presiders at the MCTM 1990 Spring Conference.

The collaborative provided teachers with an opportunity to participate in local conferences that focused on key issues in the mathematics reform movement. In January, 1988, the collaborative paid the registration fee for eight teachers to attend a two-day conference on Quantitative Literacy; in April, 1989, the collaborative sponsored the attendance of four teachers at an all-day conference on Mathematics Equity; and in May, 1989, collaborative teachers participated in a discussion on the state's response to the NCTM *Standards*.

Teachers from the Twin Cities collaborative began to assume some of the responsibility for presenting professional development programs to their colleagues. Teachers were the featured speakers at several of the dinner meetings of the TCMS and five teachers from the TCUMC presented an all-day workshop on graphing calculators.

Teacher Leadership

The collaborative has been effective in fostering the development of leadership skills for some teachers in the collaborative. The Woodrow Wilson Summer Institutes helped to motivate five Minnesota teachers (including three TCUMC members) to attend the 1989 Woodrow Wilson Foundation Algebra Institute in Princeton, New Jersey and, as a

result, to compete for selection as Woodrow Wilson Master Teachers. These Minnesota teachers, who were among the 50 teachers selected out of 1,500 applicants, were awarded a $5,000 Woodrow Wilson grant to conduct two workshops in Minnesota and a $4,800 travel grant to make presentations at the NCTM regional meetings in Madison, Wisconsin, in October, 1990; in Sacramento, California, in February, 1991; and at the 1991 NCTM Annual Meeting in New Orleans.

In December, 1989, the collaborative held a leadership training workshop for its Governing Board and Building Representatives to help participants understand how to work together more effectively and to plan for the future. The workshop, which was co-sponsored by the UMC Technical Assistance and Outreach Projects at the Education Development Center (EDC), focused on communication and organizational structure. Mark Driscoll of EDC led a session on effective communication in which he stressed the importance of assertive sharing and active listening. The 33 attendees also participated in one of six concurrent brainstorming sessions, each addressing a specific topic: Mathematics Society Dinner Meetings, Program Development, Communications, Finances, Involvement, and A Vision for the Future of TCUMC. In general, while participants felt that the workshop was worthwhile, some expressed concern that not all of the questions regarding collaborative governance had been answered and that the workshop was not long enough to accomplish its goal.

F. Reflections

From its beginning, the Twin City Urban Mathematics Collaborative has maintained its focus on extending a sense of professionalism among teachers, stimulating intellectual growth, and establishing collegial relationships. As the host institution, the Special Projects Office of the School of Mathematics of the University of Minnesota-Minneapolis has clearly set the tone for a collaborative committed to mathematics and its applications and has played an active role in directing the TCUMC toward reform. The teachers targeted by the collaborative--the 260 mathematics teachers in Grades 7 through 12 in the two school districts--were identified at the time the collaborative was established. Compared to other collaboratives, the TCUMC has operated on a relatively modest budget by keeping administrative costs low, using volunteers when possible, relying on a part-time coordinator who attends to administrative concerns rather than

providing leadership and motivation to teachers, and by maintaining a core set of activities. This has reduced, but not eliminated, the need for fund raising. People from business and higher education have been engaged in collaborative activities through their common interest in mathematics and its applications. Central to this strategy is the Twin City Mathematics Society, whose members interact with each other and participate in presentations. Another feature of the TCUMC's approach to collaboration has been an unspoken assumption that teachers have equal ranking among the members of the mathematics-using community and can exercise their own initiative in planning and identifying needed challenges. The Building Representatives, for example, develop and implement their own activities. Furthermore, Society presentations covered mathematical topics of interest to a wide spectrum of mathematics-users and were not scaled down to preconceived notions of teacher comprehension levels. Thus, reaching out to mathematics teachers in the Twin Cities, the TCUMC has enriched the mathematics education environment. Because of the importance of the state in instituting education initiatives, one challenge and source of future growth for the collaborative will be to extend these ideas and relationships statewide.

The Twin Cities Urban Mathematics Collaborative has been successful in fostering a cohesive mathematics community of teachers, business people, representatives from higher education, and others. The collaborative has also influenced state mathematics activities such as the Minnesota Mathematics Mobilization--willing and interested teachers assumed some of the responsibilities associated with that organization. Some teachers became more active in establishing mathematics leagues for middle school students, while others who became Master Teachers as a result of their participation in the Woodrow Wilson Summer Institutes assumed leadership roles in that organization. The Mathematics Society has also generated interaction among individuals from business and higher education, informing them about mathematics in general as well as about the issues that teachers face. In addition, the Society dinner programs provided teachers with new ways of thinking about mathematics as an alternative to the pragmatics of the classroom. The collaborative has helped to bridge the gulf between the two school districts so that now mathematics teachers in one district know and actively work with their counterparts in the other. This interaction is reinforced by the Building Representatives, who provide a forum for teachers and inform them of programs of special interest to them. The Building Representative group has also provided the representatives from the two cities with both a focus and an opportunity to address common goals such as equity and teaching in a

multicultural environment. All of the mathematics teachers in the two districts have at least heard about the collaborative. A high percentage of them have attended an activity and about 50 teachers emerged as a very active core in the collaborative and in its governance.

Throughout its history, the collaborative has struggled with the relationship between its administration and the core group of active teachers. The initial problem seemed to stem from stereotypes the teachers had toward those in higher education, whom they regarded as more paternalistic than collaborative. This attitude translated into a perception that the collaborative director was too controlling. In contrast, the collaborative administration had hoped that teachers would assume more leadership and responsibility for the collaborative. This lack of understanding and the differences in perception between the teachers and the representatives from higher education have never been completely resolved. After five years, these differences were still manifested in such patterns as the teachers approaching decision making through consensus while the Governing Board has tended toward the use of Robert's Rules of Order. Whereas other collaboratives worked to establish relationships and nurtured teachers to become more active in decision making, the TCUMC assumed from the beginning that all partners had equal status and should assume equal responsibility. This ignored differences in working conditions, organizational experience, and other factors that made it difficult for some teachers to immediately become functional members of governing bodies. Another problem in the development of the collaborative has been the lack of interaction with top-level administration in either of the districts. The collaborative gained the districts' support through the involvement of the two mathematics supervisors, financial contributions to the collaborative, and the participation of a school board member on the Governing Board. But the districts' superintendents were never involved in collaborative activities, nor was the collaborative seen as an important source of support for the districts' overall goals. As such, the collaborative did not become strategically situated within the two districts--a goal some of the other collaboratives have been able to achieve.

The difficulty in developing interaction between the collaborative and the two districts involves many issues. On the surface, each district has supported the collaborative by granting a small amount of funding. The two district mathematics supervisors have been active participants on the Governing Board and in other collaborative activities. While the collaborative has provided significant professional

development opportunities for mathematics teachers in each of the districts, the collaborative's efforts seem to be viewed as lying outside the district's goals. The question remains as to how greatly each district values or acknowledges these experiences, particularly when teachers seek release time to attend a conference or national meeting. The collaborative has attempted to better situate itself by increasing its overtures to the two districts, such as including a member of the St. Paul Board of Education on its Governing Board.

In retrospect, a more effective relationship could have been developed initially between teachers and the collaborative director. This would have helped teachers to better understand the constraints placed on the operation of the collaborative and helped the collaborative administration in coming to terms with the issues and challenges classroom teachers face. However, the operation of the collaborative has been too structured for people really to get to know each other. Also, more effort could have been made to bring the collaborative to the attention of the two district superintendents and to develop a stronger relationship with the district administrations in furthering programmatic changes rather than changes among individual teachers. But even given these issues, the Twin Cities Urban Mathematics Collaborative has accomplished a great deal.

Collaboration Outcomes

As noted by one business representative, the Twin Cities Urban Mathematics Collaborative has provided the seeds for an active, cohesive mathematics community in Minneapolis-St. Paul. Committed individuals from business, higher education, the school districts, and private schools have contributed time and energy to the success of the collaborative. Dinner meetings have provided opportunities for members of these different sectors to interact with one another and to hear presentations on mathematics. As noted above, members of each sector serve on the Governing Board and interact in the course of carrying on the business of the collaborative. One important outcome, as pointed out by a person who has been active in collaborative administration, was that, after five years, representatives from business and higher education and teachers continue to sit down together and work with one another. As a result of this process, some trust among the different groups has been generated.

Business people are motivated to participate in the collaborative for personal reasons and to contribute to solving what is seen as a crisis in mathematics--i.e., the challenge to society of producing citizens whose knowledge of mathematics and science will enable them to perform the jobs of the future. One individual from the business sector valued dialogue about mathematics issues at the grassroots level. Those from higher education are appreciative of the efforts to improve the quality of school mathematics, which is having the effect of increasing the number of students who take mathematics after high school. The districts benefit through TCUMC programs that address professional development for teachers--programs that otherwise would be difficult to finance. Teachers who attended the graphing calculator workshops were given a graphing calculator. One teacher noted that the districts could not afford to do this on their own.

Teachers acknowledge the importance of interaction with those from the other sectors, but the most important form of collaboration they have experienced is with each other as a result of their contact at meetings of the Building Representatives, at the dinner meetings, and at other collaborative activities. As a result of getting to know each other better, some of the teachers have taken initiative in collaborating with other teachers on special projects. One example is the development of the junior high school mathematics leagues by collaborative teachers in St. Paul. Junior high school teams now exist in approximately 60 schools in different regions of the state. The three TCUMC teachers who attended a Woodrow Wilson Institute in Princeton during the summer of 1989 continued to meet monthly along with two others from the area who had attended the same institute. As a result of these meetings, the teachers decided to approach the state for funding of regional centers at which mathematics teachers could attend institutes on new ways of teaching algebra.

Professionalism Outcomes

One effect of collaborative programs has been an increase in the professional activities of a group of mathematics teachers in the Twin Cities area who are attending conferences and other professional meetings, writing proposals, and giving each other support. Over the course of the collaborative's development, several mathematics teachers in the Twin Cities have been given special honors such as Presidential Awards, selection as Woodrow Wilson Master Teachers, and assignments on state and district committees. The

St. Paul mathematics supervisor acknowledges that, due to the large number involved, collaborative teachers are very visible in district activities.

Because the collaborative emphasizes activities that increase teachers' mathematical knowledge, teachers are learning more mathematics and becoming more confident in their teaching. Equally important, teachers' self-confidence has been enhanced as they learn to view their role differently--working together to create links across the two districts, and even beyond.

One impact of the collaborative has been to foster greater risk-taking on the part of some mathematics teachers, who are becoming better acquainted, less isolated, and who encourage each other in developing new ideas--a phenomenon observed by others who have been active in the collaborative. A business representative suggested that one of the most important benefits of the collaborative was giving mathematics teachers a different feel for their job and for other teachers.

Some teachers have attributed significant changes in their feeling of professionalism to the collaborative. A teacher who has been very active in the TCUMC noted how it has developed her leadership qualities, "I was very quiet and taught in a style of teaching much like I was taught. I wasn't aware of all the ideas and changes going on. My classes were becoming more and more difficult to teach because of the problems of urban students. Being able to network, get new ideas, and become involved in the collaborative has literally changed me for the better. I really believe it has made a great difference in my career and can't understand why others don't make time for it."

The fact that 102 teachers returned ballots in the spring 1990 election of candidates for collaborative teacher leadership indicates that about half of the Twin Cities mathematics teachers are interested enough in the collaborative to vote. Those 30 to 40 teachers who serve on the Building Representatives and its Executive Committee form the core of the most active teachers. Within this very active center, teachers from both districts have demonstrated initiative in developing programs. However, certain teachers in the core group as well as some others are perceived by certain Governing Board members as having failed to demonstrate initiative in devising ideas and soliciting help from others to overcome barriers to change.

Efforts to develop teacher leadership have been effective for some teachers, but this is an area that not all collaborative participants view in the same way. Teachers see their work with the Building Representatives group and other teacher-initiated activities as a demonstration of teacher professionalism. But representatives of higher education and business question the level of professionalism of teachers who, for example, feel they lack authority or who express anger at decisions made according to rules set by the Governing Board. Some collaborative participants have noted the difficulty that teachers seem to have in formulating their ideas and being able to communicate them to people in other sectors, such as business and higher education. Finally, some Board members see teachers as more interested in focusing on the differences between themselves and those from the other sectors than in recognizing the value of working with them as colleagues. Another area in which teachers' skills have been questioned is budget development.

Teachers responding to the 1990 Survey of Teacher Professionalism portrayed themselves as personally very committed to the social value of teaching. This was particularly the case for those with greater involvement in the collaborative. This deep belief in the value of their work stood in sharp contrast to the belief among a large number of the teachers that their work was not recognized sufficiently by the community at large. The collaborative does not appear to have increased the recognition of mathematics teachers in the community. This is evidenced in the reduction of the mathematics consultant position by one of the two school boards, the failure to consult with teachers on the school restructuring being undertaken, and, within the collaborative, the strain that exists between some of the teachers and certain representatives from other sectors.

While overwhelmingly seeing themselves as primarily teachers rather than as mathematicians, the teachers responding to the Professionalism Survey generally felt that they valued and were comfortable in their interactions with mathematicians and other users of mathematics, although a number of teachers who were Occasional participants in collaborative activities indicated some reservation in this. While feeling strongly that continuing their development in mathematics was important to them, the mathematics teachers responding did not display consensus as to whether this was more important than developing their skills in teaching and classroom management.

Very few of the respondents felt that they lacked the opportunity to make the day-to-day decisions associated with their work. The strength of their belief in their autonomy seems to be related to their level of participation in the collaborative. The extent to which mathematics teachers should be primarily responsible for review of their own and peers' work is not so clear cut. The majority held very strongly to the view that this should be the case, whereas about 25 percent did not. Participation in the collaborative does appear to be related to the relationship between the teachers and their professional organizations as defined by the reading of journals, attendance at meetings, and a belief in the value of these bodies to ordinary teachers. Views held about the role and value of the professional organizations for setting standards and implementing reform were uniformly very high for virtually all of the mathematics teachers answering the survey.

Mathematics Focus Outcomes

The mathematics focus in the Twin Cities has continued to be strongly directed by a commitment to reform and a sophisticated notion of mathematics. This is in part a result of locating the collaborative within the Special Projects Office of the Mathematics Department at the University of Minnesota. Those who have been active in the collaborative during the course of its evolution speak of its success in developing and attracting members of the community based on a shared interest in mathematics. Participating teachers have indicated that the collaborative has influenced their thinking on what should be included in the curriculum, how mathematics can be applied, and how students should be taught mathematics. Summer Institutes and other collaborative programs have contributed to TCUMC teachers doing more with problem solving, data analysis, and statistics with their students. The strong link of the TCUMC with those in higher education and the school districts' efforts to promote a more progressive view of mathematics instruction has resulted in a greater percentage of Twin Cities teachers viewing mathematics as dynamic inquiry compared to teachers from other collaboratives. A higher percentage of Twin Cities collaborative teachers value the use of calculators and computers in facilitating the learning process, as well as the importance of being active in professional organizations. In addition, the collaborative's emphasis on the development of curriculum materials and on problem solving by classroom teachers was reflected in the Outreach Grant proposal submitted by a group of collaborative teachers to EDC on preparing middle school curriculum.

By keeping its members informed of the current recommendations and issues in mathematics education and by encouraging networking with others in the state, the collaborative has increased the activity of teachers at both the state and national levels. Significantly, in 1989-90, six collaborative members served on the 36-member Governor's Task Force on Mathematics, Science, Technology, and International Education and had the opportunity to influence state policy development in mathematics education. This gave the TCUMC teachers a forum for the recognition of innovative programs, as well as an opportunity to extend their influence beyond the two districts to the entire state. On the national level, one of the collaborative teachers attending the Woodrow Wilson Institute in Princeton was selected to serve on a highly selective traveling team that gained national prominence.

For a number of teachers, the collaborative's impact on how they view mathematics and what they know about the current reform efforts has reportedly translated into classroom practice. The collaborative has also helped to increase teachers' attention to issues of equity related to providing mathematics to all students; this has resulted in some teachers promoting student study groups and cooperative learning.

The Outreach Grant proposal prepared by teachers and submitted to EDC is indicative of the work of the collaborative and its history. The proposal, seeking funds to support curriculum development over the summer and the field testing of materials during the year, was a natural outgrowth of the early stages of the collaborative when teachers participated in the collaborative Summer Institutes and then, based on their experience, produced materials to test during the school year and to share with the other participants. In both the Summer Institutes and the proposed curriculum development effort, the collaborative has held the position that real change must occur statewide rather than only locally and that it must involve such basic initiatives as the development of curriculum materials that can be shared with others in the district or state. The proposal's focus for the Summer of 1990, the development of materials for junior high school, indicates the influence of current recommendations as well as the work of the total UMC enterprise. The main rationale for working with the junior high school curriculum was to provide students with strong mathematics experiences in algebra that would prepare them to successfully complete other high school mathematics courses. The curriculum, supporting national recommendations to increase the level of mathematics taken by all high school students, also addressed equity issues, including program components to provide students

with role models of females and other underrepresented groups in work areas heavily dependent on a knowledge of mathematics. Thus, the proposal summarized the efforts of the Twin Cities Urban Mathematics Collaborative to draw upon the rich resources in the area in providing teachers with sound mathematical experiences. Such experiences involve teachers in addressing equity and mathematics reform through processes that can be widely disseminated within the Twin Cities and to other districts in the state.

Conclusions

The Twin Cities Urban Mathematics Collaborative successfully fulfilled its original purposes: extending the sense of professionalism among secondary school mathematics teachers through having teachers become more active in professional organizations; keeping teachers informed of current trends in mathematics education; and fostering the development of the Building Representatives group so that it assumed more responsibility for addressing specific needs of teachers. The collaborative provided teachers with intellectual stimulation and renewal through Summer Institutes, Mathematics Society presentations, workshops, and opportunities to attend meetings sponsored by other organizations. Collegial and professional relationships among the teachers and the wider mathematics community of the Twin Cities were strengthened through the Mathematics Society dinner meetings, the interaction among the Governing Board members, a site visit to an area business, and committee work for collaborative planning and proposal writing.

The Twin Cities Urban Mathematics Collaborative demonstrated that a collaborative could be operated out of a university department with relatively low administrative costs. While this close association with a mathematics department assured a strong mathematics focus for the collaborative, it also meant that university policies and regulations were factors in hiring procedures and money allocations. This placed some constraints on the collaborative that were not experienced by collaboratives operated through public education funds. One observable difference between TCUMC and other collaboratives was that the TCUMC coordinator operated primarily as an office administrator taking direction from the Governing Board, rather than working with teachers and providing guidance in their planning. Raising outside funds, which required some effort of the collaborative administration, was successful and maintained the collaborative on a financially sound basis.

The collaborative provided a vehicle for enhanced communication throughout the mathematics community in the Twin Cities. Faculty from the numerous area universities and colleges were able to form links with secondary mathematics teachers. Individuals from local businesses had opportunities to talk with teachers about their work. Some of the business representatives became very active and worked closely with teachers and others in developing plans for the collaborative. For the first time, mathematics teachers from the two cities became acquainted with each other and started to work together. Perhaps the most important impact of the TCUMC will be the new relationships forged among teachers, both those new to the profession and the veterans.

As the collaborative makes the transition to the future, its active Governing Board has the potential to guide it toward a permanent organizational structure. One force acting against the formation of such a structure is the lack of agreement between the active teachers and the collaborative administration on the operation of the collaborative. Another force is the dynamic changes taking place within the districts. Because the collaborative has not been strongly linked to the central administration of the districts, it may not be in a position to influence the direction the districts take in mathematics education. A more permanent status for the collaborative would be assured if it were seen by the districts as vital to their goals. What is interesting about the future of the collaborative is that financial issues are not a dominant factor. A more important factor is strengthening the relationships among active collaborative participants. The progressive posture the collaborative has taken to increase the knowledge of teachers and others about mathematics and mathematics education reform continues to be a potentially powerful force.

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